ALGORITHMIZATION FOR PROCESSES OF REGIONAL DIFFERENTIATION AND CONCENTRATION OF INVESTMENTS IN RUSSIAN AGRICULTURE

Tatiana Vorozheykina [a*], Vadim Demichev [b], Vesta Maslakova [b], Marina Leshcheva [c]

[a] *Department of Production Organization, Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, RUSSIA.*
[b] *Department of Statistics and Econometrics, Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, RUSSIA.*
[c] *Department of Economic Analysis and Audit, Stavropol State Agrarian University, RUSSIA.*

A R T I C L E I N F O	A B S T R A C T
	This work presents the results of the development of an algorithm for assessing regional differentiation and concentration of investments in Russian agriculture. The stages and methods of researching these processes are formulated. The analysis of the dynamics of investments in agriculture and the forecast of the dynamics of the regional concentration of investments and production are presented. The study is done at the macro level. The selection of units by the type of study population was carried out using statistical groups. The degree of regional differentiation and concentration of investment and production was determined on the basis of the calculation of the Herfindahl-Hirschman coefficient and the Gini coefficient. Recommendations were made on adjusting the investment process, taking into account the implementation of state programs to improve the efficiency of investments in agriculture. **Disciplinary**: Agricultural Economics and Investments.

1. INTRODUCTION

In modern conditions of economic development, investment is the key factor stimulating production growth, increasing its economic efficiency. Investments are one of the main tools for the implementation and distribution of financial resources. Investments in agriculture allow conducting effectively expanded reproduction using new technologies, means of production, innovative solutions. That results in increased competitiveness of both individual economic entities and the country's economy as a whole. The period of implementation of state programs is the period begins in 2006.

From 2006 to 2017, investments in Russian agriculture increased by 68.5%. It allows increasing

volumes of agricultural production by 18.6% under the study period. This period is connected with the implementation of the "State program of development of agriculture and regulation of markets of agricultural products, raw materials and food for 2008-2012" and for the period from 2013 to 2020 [17]. Let's examine some results of these programs.

During the period under review, 1,852 new facilities were constructed, 948 of them are dairy farms, 497 beef cattle farms, 282 pig farms and 125 poultry farms. During the period of state programs implementation 1,562 farms were reconstructed, 1028 of them were dairy farms (Table 1). However, with the growth of new premises, the number of reconstructed objects in dairy cattle compared to 2009 decreased by 60.2%.

Investors prefer new construction, as it makes it possible to build an object using modern technologies, and the renewal of existing facilities can cost more than new construction [15].

It is also worth saying that, despite the additional production of 1535.5 thousand tons of milk for the analyzed period, the indicator of food security Doctrine for dairy cattle breeding has not been fulfilled by this moment. With the required volume of milk production in the total resource 90% at the end of 2017, it was produced 82.4% in the country [12].

Otherwise, the situation in beef cattle breeding differs a lot. For the first time in 2015, the actual indicator "share of meat and meat products in total resources" (87.4%) exceeded the indicator of Doctrine of food security (85%). At the end of 2017, the indicator amounted to 90.4%. It should be noted that the increase in the production of cattle meat is unstable. The increase in production volumes in 2015 in contrast with last year amounts to 5.6 times, which is explained by the implementation of the Miratorg agricultural project for the construction of a slaughterhouse and processing of cattle. The increase in agriculture also resulted in changes in the qualitative composition of cattle herds: it is marked the growth of specialized beef and crossbred cattle in the total structure of cattle, which share in 2008 amounted to 2% and in 2015 and 15.7% [12].

A significant increase in production volumes for the analyzed period in the amount of 100% is observed in poultry. This growth is achieved by a comprehensive modernization of the industry. In just 9 years, 1635 thousand tons of poultry meat were produced at new and reconstructed facilities.

Additional production of pork meat for the analyzed period amounted to 730,2 thousand tons. About 4% of all pork products are produced at new and reconstructed facilities. However, the economic sanctions imposed by the EU countries, the devaluation of the national currency led to a cost increase of 15-17% [12].

It should be concluded that the high capital intensity of projects in the field of dairy and beef cattle, as well as long-term payback, make them less attractive to investors. Taking into account the fact that these areas are a priority for the country's economy, the indicators of the Doctrine of food security are not fulfilled by dairy cattle. The cattle population has decreased by 15.2% in eleven years since 2006, including dairy herd that has decreased by 15.0% [6]. It should also be noted that, despite the positive dynamics, the share of specialized beef cattle in the total cattle population remains at a low level to meet the demand for beef. According to the experience of developed countries, the share of specialized livestock should be 40-85% [3], while in Russia this figure is about 16%.

These changes in the volume of investment and production of agricultural products have a number of features that reveal the significant problems of the modern economy of agriculture in Russia.

Investment is a process of allocation money associated with a certain level of risk in the

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expectation of some benefit in the future. This paper is related to a large literature on investment. Investment as a subject of study is researched by Favara and Morellec (2017), Frank and Shen (2015), Guadalupe et al. (2012), Hsu et al. (2014), Edmans et al. (2015), Bebchuk et al. (2017). Favara and Morellec (2017) characterize investments as capital expenditures in the year. An alternative measure of investment is asset growth, which is a growth in total assets for a period of time.

Risk is the potential for uncontrolled loss of value. Investment risk is caused by a lack of an effective price regulation system, the high dependence of natural and climatic conditions, low rates of modernization, poorly developed infrastructure, financial instability and a shortage of qualified personnel. According to Frank and Shen (2015) in the asset pricing literature, tracing out the impact of risk on returns is often the key issue. Taking into account a certain level of risk investor place financial resources in order to obtain a benefit, which ought to be not an only financial one. Guadalupe (2012) show that direct investment has a positive impact on innovation in local firms through technology and know-how transfer. Hsu et al. (2014) find that equity market development positively affects innovation. Direct investments also lead to infrastructure development, contribute to logistics and transportation.

A number of papers focus on the same methods of study the author applies during the research, among them: regional differentiation and concentration, statistical grouping, coefficient calculation method and charting.

The concentration of institutional ownership of the twenty largest US corporations which shows a result of the rise of institutional investors is analyzed by Bebchuk et al. (2017). Statistical grouping is widely applied by Favara et al. (2017), for instance, authors analyze the correlation between default probability and debt enforcement grouping firm characteristics. The coefficient calculation method is used by Frank and Shen (2015), while the authors study how the weighted average cost of capital (WACC) affects corporate investment. Edmans et al. (2016) compute coefficients of return on assets ratio, the value of debt divided by total assets, change in the ratio of cost of goods to sales and change in the ratio of operating expenses to sales in order to study the link between real investment decisions and short-term price concerns.

Charting is one of the most widely applied methods. Lin (2013), Tang et al. (2014), Carlson et al. (2006) present obtained results by means of charting.

2. METHOD

Regional differentiation and concentration of investment are the most important characteristics of the sustainable reproduction of the Russian agricultural economy. This is due to the natural and climatic and territorial diversity of the country. The study includes several methods (Table 1), the consistent use of which allows us to achieve the goals. We use the method of constructing an interval series of distribution in order to group regions in terms of the proportion of investments in agriculture in the total volume of investments. Groups were allocated by allocating intervals, which included regions with a low, medium and high level of the indicator. The same method was used to group regions by the share of investments in Russian agriculture. For each selected group, a system of indicators was calculated, revealing the features of regional differentiation and concentration of investments. The main indicators used are the various indicators, including the coefficient of variation, concentration indices, including the Herfindahl-Hirschman coefficient, determined by the

formula (1), the Gini coefficient calculated by the Bernoulli formula (2).

$$HHI = \sum S_n^2 \qquad (1),$$

where S_n^2 – expressed (%) share of the characteristic in n groups.

$$G = \left| 1 - \sum_{k=2}^{n} (x_k - x_{k-1})(y_k + y_{k-1}) \right| \qquad (2),$$

where x_k; x_{k-1}; y_k; y_{k-1} - the share of the region and the studied trait in n groups.

In order to study the influence of subsidies and credit resources on the change in agricultural production resources, the method of factor grouping was used during the implementation of state programs.

Then, we analyze the features of investing in small, medium and large agricultural organizations. The Russian agribusiness tends to enlarge the size of organizations. According to the Russian agricultural census 2006 and 2016 years, in 2006, one agricultural organization accounted for an average of 2.2 thousand hectares, and in 2016 it was 2.5 thousand hectares, the average number of cattle was 587 and 785, respectively (see more source 20). Thus, it is advisable to consider investment processes in organizations of different types.

Table 1: Stages and methods for studying regional differentiation and concentration of investments in agriculture in Russia

Stage	Method	Expected result
1.	Analysis of dynamics (in this case investment in agriculture)	Assessment of the overall situation and identification of key investment trends
2.	The statistical grouping of regions	Determining the distribution of regions by share of investment in agriculture
3.	The calculation of the Gini coefficient. The construction of the Lorenz curve	Assessment of the degree of regional differentiation in terms of investment and agricultural production
4.	The calculation of the Herfindahl-Hirschman coefficient	Measurement of the degree of regional concentration of investments and production
5.	The factor group of regions	Study of the impact of subsidies and credit resources as indicators related to investment on the change in the resource potential of agriculture in the regions
6.	Analysis of dynamics indicators (in this case, the system of investment indicators in organizations of different types)	Identification of differences in the dynamics of indicators of investment in agricultural organizations of different types

It should be noted that the process of investing in Russian agriculture has some more features that can be continued as the next stages of the study. These features include the regional differentiation of the efficiency of the state subsidies use, the effectiveness of the subsidies distribution in the sectors of agriculture, as well as the effectiveness of investments in large, medium and small agricultural organizations.

3. RESULT AND DISCUSSION

In this article, we examine the results of the study of the concentration and distribution of investment in agriculture in Russia. As initial data, information was used on the volume of investment in agriculture in Russia and the volume of production of agricultural products by regions of the

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Russian Federation. At the first stage of the study, an interval variation of subjects was constructed according to the indicator "the share of investments in agriculture in the total volume of investments", which combined nine interval groups, which were later combined into three groups: lower, average and higher (Table 2).In the constructed typical grouping, the smallest share of investments is concentrated in the lower group (2.5%), whose representatives are the regions of the Dalnevostochny and the North Caucasus federal districts. Regions - leaders in terms of investment are Rostov, Bryansk, Voronezh and Krasnodar regions.

Table 2: Grouping of regions by the share of investments in agriculture in the total volume of investments in 2017, %

Groups of regions	Grouping of regions by the share of investments in agriculture in the total volume of investments		The number of regions, units	The share of regions	The share of investments of the regions by group	Share of production of the regions by group
1 (lower)	<	0.40	25	32.1	3.9	12.2
2 (average)	0.40	1.60	32	41.0	31.2	34.0
3 (higher)	1.60	>	21	26.9	64.9	53.8
Total			80	100.0	78.0	100.0

At the same time, based on the use of the interval variation series described earlier, the Lorenz curve presented in Figure 1 was constructed and the Gini coefficient was calculated by Formula (2) in terms of the share of investment in agriculture and the share of agricultural production. Thus, the differentiation of investments in the form of the degree of deviation of the actual distribution of investments from the absolutely equal distribution of their distribution is 46.4%, while in terms of production the degree of inequality of distribution is 32.8%.
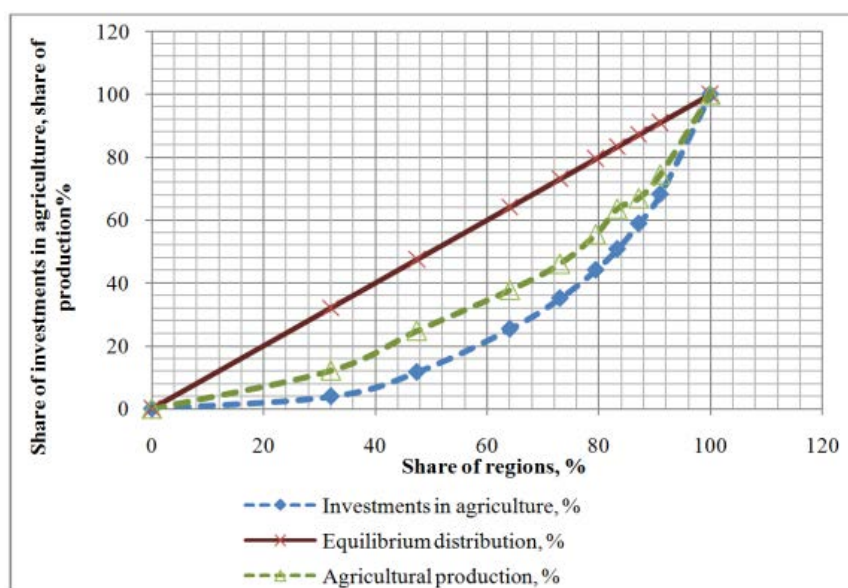

Figure 1: The Lorentz curve.

In order to assess the concentration and nature of the distribution of investment on a territorial

basis, the regions were grouped by federal districts of Russia. Grouping of regions was carried out according to data for 2017 (Table 3).

Table 3: Grouping of regions by the share of investments in agriculture in Russia

Federal district	Number of regions	The share of regions in total number, %	The share of investment in agriculture, %	The share in the production of agricultural products, %	The coefficient of variation (investment)	The coefficient of variation (production)
Central	18	22.8	39.8	26.1	88.2	82.7
The North-West	8	10.1	6.7	3.9	60.5	102.2
Southern	6	7.6	11.4	16.8	118.0	92.0
The North Caucasus	7	8.9	5.6	8.7	140.0	98.2
Privolzhsky	14	17.7	16.7	23.8	73.5	65.0
Ural	7	8.9	5.5	6.5	65.8	38.3
Siberian	11	13.9	8.3	11.1	83.3	74.2
Dalnevostochny	8	10.1	6.0	3.1	124.6	90.5
Total	79	100.0	100.0	100.0	108.2	100.0

The distribution of Federal districts is not uniform. It should be noted that the coefficient of variation on Federal districts indicates heterogeneity of groups of regions on the presented indicators.

Table 4: The Herfindahl-Hirschman coefficient on the Federal districts

Federal district	Number of regions	The Herfindahl-Hirschman coefficient (investment)	The Herfindahl-Hirschman coefficient (production)
Central	18	1587.0	679.0
The North-West	8	45.2	15.0
Southern	6	129.7	283.2
The North Caucasus	7	31.3	76.5
Privolzhsky	14	277.7	567.3
Ural	7	30.6	41.8
Siberian	11	68.4	122.9
Dalnevostochny	8	36.0	9.8
Total	79	2205.8	1795.5

The investment market in Russia is highly concentrated, as indicated by the Herfindahl-Hirschman coefficient (2,205.8 at a threshold of 1,800). The greatest concentration of investments is achieved in the Central Federal and the Privolzhsky districts, in such regions as Belgorod, Bryansk, Voronezh, against the background of lack of investments in the North-West, theNorth Caucasus, Ural, and Dalnevostochny Federal districts (Table 4).

The concentration of investments in some regions exceeds the production of agricultural products, as can be seen from the chart of the Lorenz curve (Figure 1), where the differences in the distribution of investments in agriculture are higher than in production. The situation under consideration indicates a lack of investment in certain regions if they have a productive capacity. Differences in the distribution of agricultural production are lower than differences in investment by 13.6%, as indicated by the Gini coefficient.

It is also worth noting that for the period of 11 years, since 2006, when the national project for the

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development of agriculture enters into force, the concentration of the investment market has decreased, as evidenced by the dynamics of the Herfindahl – Hirschman coefficient (Figure 2).
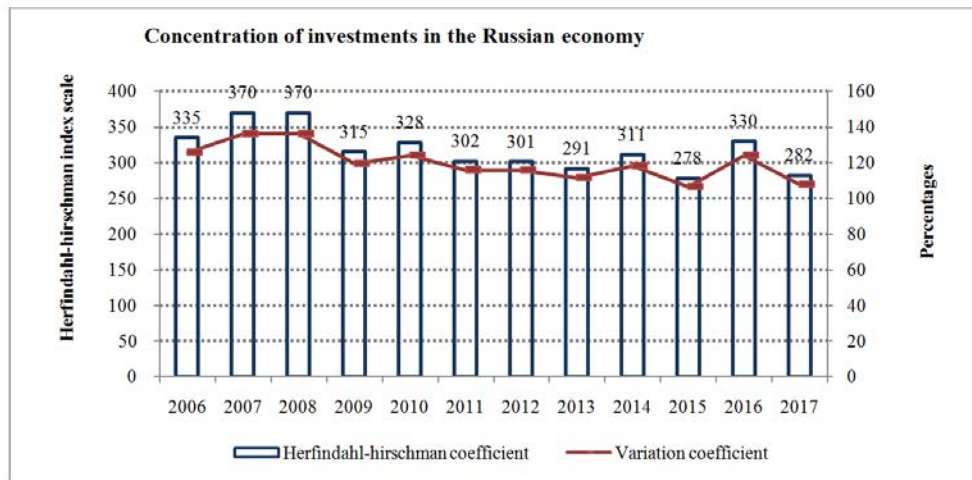

Figure 2: Concentration of agricultural investments in the Russian economy.

The totality of regions in terms of investment in fixed assets is very heterogeneous, on average the investment volume of an individual entity deviates by 120% from the average level in Russia. For the period from 2006 to 2017, the differences decreased by 18%. However, the problem of regional differentiation is still relevant [16].

Government investment is to a large extent expressed by subsidizing part of the interest rate on loans that enterprises take for current needs or the development of production. That is, investment is closely related to the volume of subsidies and loans to agricultural producers. Regional heterogeneity of investments also affects the differentiation of subsidies and credit resources used in agriculture in the regions. As a result, the degree of reproduction varies considerably from region to region.

Table 5: Impact of the share of agricultural enterprises receiving subsidies and credit resources

Groups of regions by the share of agricultural enterprises receiving subsidies in 2015, %	Subgroups of regions on the share of agricultural enterprises receiving credit resources in 2015, %		On average
	1.from 0.0 to 7.9	2. from 8.0 to 23.5	
I. from 4.8 to 21.0	-24.3	-20.5	-23.5
II. from 21.1 to 37.3	-23.5	-12.0	-15.2
III. from 37.4 to 53.6	12.3	-13.4	-13.0
On average	-18.4	-13.5	-15.0

On average, the total number of regions, the area of agricultural land decreased by 15.0% (Table 5). A comparison of the average growth rate of the indicator shows that the degree of decrease in the area of agricultural land in 2016 compared to 2006 is naturally reduced. That is, the increase in the share of those who use subsidies and credit resources leads to a slowdown in the reduction of agricultural land. It is especially worth noting that with a high level of subsidies and a low level of loans to agricultural enterprises, the resource potential can be increased. That is, with the share of enterprises receiving subsidies in the range from 37.4% to 53.6% and the share of enterprises using credit resources, the area of agricultural land has not decreased, but on the contrary, it has increased

by 12.3%. The increase in state support, it is more even distribution across regions, will contribute to the reduction of negative trends in the reduction of the resource potential of agriculture. Investment processes in large and small enterprises also vary significantly. Consider the results of the analysis of investing in large and small organizations.

Table 6: Agriculture fixed capital investments of large and medium-sized enterprises

Indicators	2011	2012	2013	2014	2015	2016	2017	2017/ 2016, %
Fixed agricultural capital investments in total, bn. rub.	446.9	476.4	516.6	510.3	505.8	611.2	545.4	89.2
The growth rate of investments in fixed assets, total, %	134.8	101.0	103.9	94.7	88.1	112.3	89.2	-23.1
Investments in fixed assets of large and medium-sized enterprises, bn. rub.	346.2	376.5	425.0	414.0	408.8	490.1	412.5	84.2
The growth rate of investments in fixed assets of large and medium-sized enterprises, %	-	108.8	112.9	97.4	98.7	119.9	84.2	-35.7
Federal budget capital investments, bn. rub.	4.9	5.0	6.6	7.0	9.4	11.3	9.5	84.2
The growth rate of federal budget capital investments, %	-	102.0	132.0	106.1	134.0	120.0	84.2	-35.8
Profitability of agricultural production, %	9.9	12.0	5.8	18.6	19.0	16.8	17.0	0.2

The volume of investments sent to large enterprises in 2017 is 3 times higher than the index for small business entities (see Tables 6 and 7). Large enterprises for the period from 2011 to 2013, in contrast to small companies demonstrate a positive dynamics of investment growth. In 2013, the increase was 12.7%, which is 6.4% higher than the inflation of the corresponding year. The slowdown in investment growth in 2014 is due to the embargo imposed by EU countries in 2014 on the import of agricultural products. However, the annual growth rate of large enterprises shows positive dynamics. Investments in fixed assets of small enterprises are growing during the period from 2014 to 2017. In 2016, 2017, the rate of growth in investment in the fixed assets of small enterprises exceeds a similar indicator of large enterprises.

Table 7: Agriculture fixed capital investments ofsmall enterprises

Indicators	2011	2012	2013	2014	2015	2016	2017	2017/ 2016, %
Investments in fixed assets of small enterprises, bn. rub.	100.7	99.9	91.6	96.3	97.0	121.1	132.9	109.7
The growth rate of investments in fixed assets of small enterprises, %	90.0	99.0	92.0	105.0	101.0	125.0	109.7	-15.1
The inflation rate, %	106.1	106.6	106.5	111.4	112.9	105.4	102.5	-2.9
Profitability of agricultural production, %	9.3	10.6	6.7	11.4	18.1	15.6	16	0.4

Investments of capital under existing conditions are economically justified mainly in large organizations, they generate profits from the capitalization of investments. The profitability of agricultural production in the large organizations exceeds the index of small business entities on average by 1.5%. For small enterprises, it is necessary to conduct a special state policy that allows forming the mechanism of investment development.
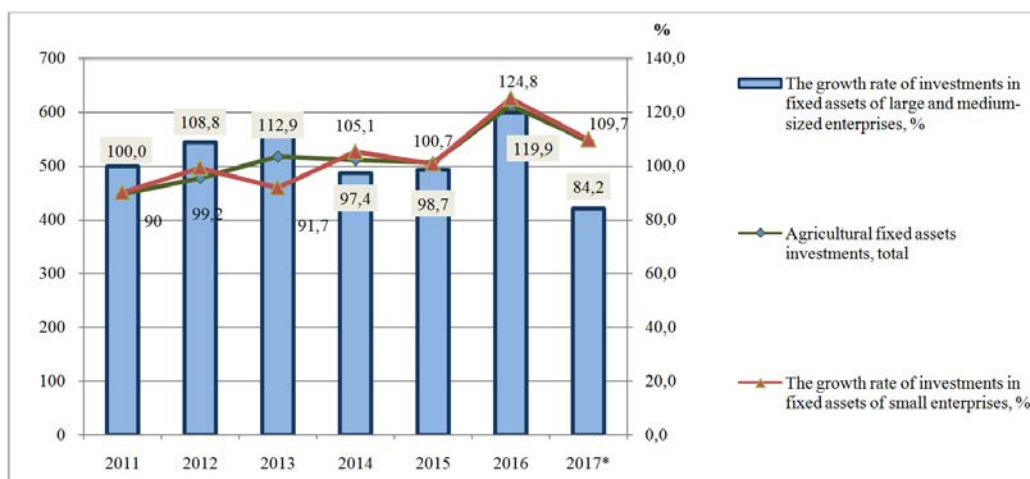
Figure 3: The dynamics of fixed assets investments of large, medium-sized and small enterprises

The total amount of investments in agriculture is increasing (Figure 3). Agriculture is becoming one of the leading industries providing economical growth. Only for the last 5 years, investments increased by 36.8%. In recent years there has been a tendency to outstrip the growth rate of investments in small organizations over the same indicator for medium and large organizations.

4. CONCLUSION

There are results of increasing the production of individual agricultural products. As a result, the total investment in agriculture has also increased. However, the problems of regional differentiation of investment and production, excessive concentration of production, uneven distribution of agricultural subsidies remain unresolved. The solution to these problems will allow increasing the stability of the agriculture economy of Russia. State programs should not only aim at increasing investment in absolute terms but should also contribute to economic stability, reduce regional differentiation and preserve equal opportunities for all agricultural producers.

5. DATA AND MATERIAL AVAILABILITY

Data can be made available by contacting the corresponding author.

6. REFERENCES

[1] Bebchuk, L.A., Cohen, A., Hirst, S. (2017). The Agency Problems of Institutional Investors. *Journal of Economic Perspectives*, 31, 89; 112.

[2] Carlos, M., Fisher, A., Giammarino, R. (2006). Corporate investment and asset price dynamics. Implications for seo event studies and long-run performance. *Journal of Finance*, 61, 1009-1034.

[3] Ferma. (2018). Development of beef cattle breeding in Russia. http://www.agro-ferma.ru/dayatelnost/ferma-krs/ferma-krs-stati/razvitie (Accessed 27.01.2018).

[4] Edmans, A., Fang, V. W., Lewellen, K. A. (2017). Equity Vesting and Investment. *The Review of Financial Studies*, 30, 2229-2271.

[5] Favara, G., Morellec, E., Schroth, E., Valta, P. (2017). Debt enforcement, investment, and risk-taking across countries. *Journal of Financial Economics*, 123 (2017), 22-41.

[6] GKS. 2018. Federal State Statistics Service. http://www.gks.ru (Accessed March 2018).

[7] Frank, M. Z., Shen, T., 2015. Investment and Weighted Average Cost of Capital. *Journal of Financial Economics*, 119, 300 – 315.

[8] Guadalupe, M., Kuzmina, O., Thomas, C. (2012). Innovation and foreign ownership. *American Economic Review*, 102, 3594-3627.

[9] Hsu, P., Tian, X., Xu, Y., 2014. Financial development and innovation: cross-country evidence. *Journal of Financial Economics*, 112, 116-135.

[10] Liu, L., Whited, T., Zhang, L., 2019. Investment – based expected stock returns. *Journal of Political Economy*, 117, 1105-1139.

[11] Lin, X., Zhang, L., 2013. The investment manifesto. *Journal of Monetary Economics*, 60, 351-366.

[12] National report "On the progress and results of implementation in 2013 to 2017. State program of agricultural development and regulation of agricultural products, raw materials and food for 2013-2020 years, Official website of the Ministry of Agriculture of the Russian Federation. - http://www.mcx.ru/news/news/show/50734.355.htm (Accessed: 07.04.2018).

[13] Neshetoy, A.S. 2013. Investments: textbook. 8th Ed. – Moscow, Dashkov and Co, P. 370.

[14] Petty, V., Smith, A., Ricardo, D., Keynes, J.M., Friedman M. *Classics of economic thought*. M, EKSMO PRESS, 2000. P. 896.

[15] AgroInvestor. 2013. Play in large scale. №1 http://www.agroinvestor.ru/ technologies/article/15008 (Accessed 20.03.2018).

[16] Polyakov, E. Reasons for the recession are internal http://expert.ru/expert/ 2013/46 (Accessed 20.02.2018).

[17] State program for development of agriculture and regulation of agricultural products, raw materials and food for 2008-2012 and 2013 - 2020 years. Official website of the Ministry of Agriculture of Russia. http://www.mcx.ru (Accessed 06.04.2018).

[18] Tang, Y., Wu, J. G., Zhang, L., 2014. Do anomalies existexante? *Review of Finance*, 18, 843 – 875.

[19] The statistical book "Russian Agribusiness in 2015". Official site of Russia's Ministry of Agriculture. www.mcx.ru.

Dr.Tatiana Vorozheykina is an Associate Professor, Department of Production Organization, Russian State Agrarian University - Moscow Timiryazev Agricultural Academy. She holds a Doctor of Economics.

Vadim Demichev is an Associate Professor, Department of Statistics and Econometrics, Russian State Agrarian University-Moscow Timiryazev Agricultural Academy. He is a Candidate of Economic Sciences.

Vesta Maslakova is a Lecturer at Department of Statistics and Econometrics, Russian State Agrarian University - Moscow Timiryazev Agricultural Academy. She holds a Master's degree

Professor Dr. **Marina Leshcheva** is Professor, Department of Economic Analysis and Audit, Stavropol State Agrarian University. She holds a Doctor of Economics. She is interested in Integration Processes in the Agribusiness and Agriculture.